Quantifying C-17 Aircrew Training Priorities

GRADUATE RESEARCH PAPER

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Abstract

This research investigates the possibility of prioritizing and quantifying of C-17 pilot training/currency flight events. Currently, the 11-2C-17 Volume 1 does not prioritize training events, only mandates the minimum number of flight events a pilot must complete within a given period of time. Through interviews and surveys of C-17 experts, including high-time instructor and evaluator pilots, this research provides quantifiable coefficients for each of twenty-eight selected C-17 flight events. The coefficients are calculated as a product of the impact rankings of four categories labeled as an SPR Score: Skill Required, Skill Diminish Rate, Probability of Occurrence, and Risk. This SPR Score provides decision makers from the squadron level up through and including MAJCOM level a means by which to prioritize training events within a limited resource environment. Additionally, this coefficient allows the future possibility of optimization of C-17 sorties by linear programming to ensure AMC that each flight hour and pound of jet fuel is being maximized to the fullest utilization of providing the combatant commanders with the most proficient and trained C-17 pilots possible.

For my wife and sons

Without the love, patience, and support of my family the completion of this research would not have been possible. Their enduring and unequivocal sacrifices in support of my profession and career are without bounds, and the year spent researching and writing this paper is no exception.

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Lastly, ASAM would not be such an exemplary program without the outstanding support and administration of the Expeditionary Center staff. Thank you for investing in this program and equipping the mobility enterprise with officers that have gained the unique education and experience that only ASAM can provide.

Joseph D. Beal

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I. Introduction

General Issue

U.S. Air Force C-17 pilots are expected to be mission effective under the harshest and most demanding conditions. The flexible and responsive nature of the Air Force's core mission necessitates a high state of readiness for its pilot force. Currently, C-17 pilot readiness is determined almost exclusively via currency status. That is, a pilot is considered "ready to fight" if they have accomplished all required events within a certain maximum allowed time period of the date on which they plan to fly. The maximum time periods allowed per event are regulated by the AFI 11-2C-17 volume 1 for all C-17 events.

Problem Statement

C-17 Aircrew Training Program (ATP) is designed to provide a unit with the procedure to ensure its pilots maintain a minimum acceptable level of proficiency. The ATP has also become the primary method of determining a pilot's readiness via currency status. It is not designed in a manner in which unit leadership has an established method to ensure they are providing the combatant commander with the most qualified and proficient pilot force, only the most current. The C-17 ATP establishes a minimum amount of flight events that will maintain a pilot's status as "current" and considers all flight events to be equally important as it pertains to currency status. A program does not currently exist that provides unit decision-makers a mathematical method to ensure the most qualified warfighters are being sent to the fight.

Currency status is intended to be used as an aid to decision makers in the unit to help identify those pilots that are the most prepared to aviate under virtually any wartime or peacetime conditions. Many times, a gap exists between currency and proficiency and unit leadership is provided with near non-existent authority to acknowledge and discard currency status in order to place a more qualified pilot on a crew. Additionally, large amounts of flight hours are consumed in order for pilots to strive for and obtain currency in flight events that are often times not necessary to meet mission accomplishment or contribute to overall proficiency.

Research Objectives

The intent of this research is to explore quantifiable analytic options regarding C-17 flight training in order to provide the C-17 ATP and unit leadership with a mathematical model or system that can be to ensure the most qualified flyers are available to the combatant commander. Any results implemented could potentially lead to more effective and efficient flight hours, more proficient pilots, and a more flexible and adaptable training plan for flying squadrons.

Research Focus

The focus of this research will be limited to C-17 readiness and currency requirements defined by and compared to AFI 11-2C-17 volume 1 conditions. If any changes are recommended, a C-17A pilot readiness pilot program will be suggested at a sample unit in order to test and compare the suggested readiness model with the current ATP.

Investigative Questions

1. What is the current AMC C-17 training model?
2. How does it compare to the rest of the Air Force MDSs?
3. How do USAF currency requirements differ from the civilian U.S. Airlines?
4. Are all C-17 flight events equal?
5. Can C-17 training events be quantified and stratified?
6. What flexibility is gained at the squadron, group, and MAJCOM level?
7. Feasibility? (Hammer, M. and Champy, J., 2001)
    a. Technical – Can it be done?
    b. Economic – Can we afford it?
    c. Cultural – Will our people go for it?

Assumptions/Limitations

1. All maneuvering events logged in flight or in the simulator (sim) on any type of training or operational mission are considered “flight events”.
2. AFI 11-2MDS volume 1 data is valid through submission date of GRP.
3. Data analysis is limited to Aircraft Commander Flight Level B.
4. Research and discussion is limited to continuation training.
5. Statistical data collected from expert sources are indicative of the population when large sample sizes are not available.

II. Literature Review

Chapter Overview

The 11-2C-17 volume 1(Vol 1) is the regulatory guidance written by Air Mobility Command (AMC) for all C-17 training. The Vol 1 provides aircrew with the required minimum amount of training that AMC deems a pilot will need to operate a C-17 safely under wartime and peacetime conditions. Pilots may complete additional training in order to increase proficiency and/or capability in a given flight event. Over the past few fiscal periods, AMC has reduced flight events or moved the requirement from the aircraft to the simulator in an effort to seek cost savings. Additionally, further reduction of flight events is under investigation due to their perceived necessity or likelihood of occurrence. This change has resulted in less flight events being accomplished in the aircraft for C-17 pilots. In short, financial restrictions are reducing the capability and proficiency of the C-17 pilot force.

MAJCOM Approaches to Flight Currency

Before deeply investigating the C-17 pilot training model, an overview of Air Force-wide approaches to flight currency should be discussed. For this research, two main categories will be used: Mobility Air Forces (MAF) and Combat Air Forces (CAF). The MAF comprises of all heavy lift and air refueling airframes, while the CAF encompasses all fighter and bomber aircraft, as well as some intelligence, surveillance, and reconnaissance aircraft, such as the E-3. Generally speaking, AMC is the regulatory authority for all MAF aircraft, while, also generally speaking, Air Combat Command is the authority for all CAF aircraft. This distinction is important when comparing and contrasting the two different training model approaches to pilot currency and proficiency.

Each airframe (aircraft type) possesses its own 11-2MDS volume 1 which is the regulation and instruction authority for aircrew continuation and recurrency training. Aside from the geographical MAJCOMs (PACAF, USAFE, etc.), AMC authors the Vol 1 for the MAF and ACC authors the Vol 1 for the CAF. AMC's training program is based almost solely on currency status by flight event. AMC ensures that for a pilot to remain current, he must accomplish a flight event within a maximum period of time since last accomplishing the same event. Nearly every type of flight event is accounted for in the currency tables to ensure that an AMC pilot has is at least minimally proficient in virtually any conceivable scenario. The CAF model is significantly different. In fighter units, for example, pilots must remain "current" in only a minimal amount of "big ticket" flight events. These events include items such as Night Landing, Air Refueling, and Instrument Approach. In order for the CAF model to ensure its pilots are ready to fight, it also places a minimum number of flights that a pilot must accomplish within a certain period of time to consider that pilot "Mission Ready". In general, the MAJCOM does not dictate, or care, what those pilots do on those minimum number of flights, so long as those minimum number of currency items are accomplished and the total number of sorties meets the minimum to be Mission Ready. It is almost exclusively left to the authority of the squadron or group to decide what is accomplished on that minimum number of flights so that the pilots' training is satisfactory in line with the wing commander's vision, as he is ultimately accountable to the Numbered Air Force (NAF) and MAJCOM for the readiness of his pilots.

The distinction between the MAF and the CAF is significant for two reasons. First, it displays that there is more than one acceptable method to ensure USAF pilots are ready to deploy and fly in accordance with a combatant commander's (COCOM's) intent. Secondly, it shows that number of aircraft currency/flight events is not a direct correlation to pilot proficiency. The following figures display the discrepancies in currency flight events among USAF airframes. (Source: 11-2MDS Vol 1)

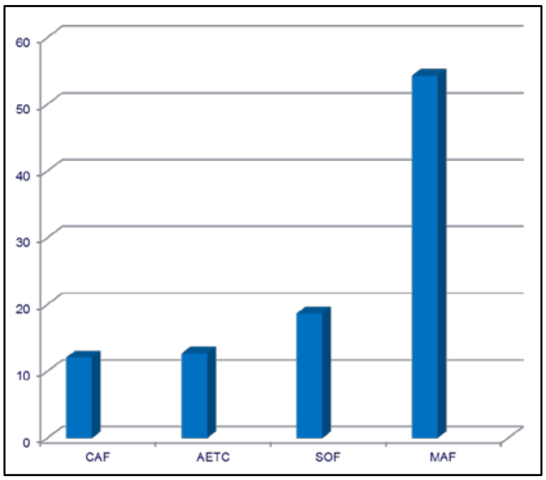

Figure 2.1 Total Number of Flight Events by Mission Type (AFI 11-2MDS Volume 1, 2006-2012)

Figure 2.1 is an illustration of the differences in approaches to flight event currency as discussed above. AMC has adopted a similar model to continuation training as that used in civilian aviation, in particular, the airline industry. This is not surprising due to the similar characteristics in aircraft between AMC and the airlines. In some cases, such as the KC-135 and KC-10, the USAF aircraft is a modified civilian airliner. However, the question begs the question, "What is it about MAF aircraft that require five times as many currency flight events to produce a minimally proficient pilot?"

A natural skepticism to the comparison in these figures flows from even the basic understanding of aircraft mission sets. It is reasonable to question the validity of this comparison due to the markedly different missions that each of these aircraft possess. Superficially, it does not seem reasonable to draw conclusions when comparing a C-17 heavy airlift aircraft with an F-22 fifth generation stealth fighter aircraft. Figure 2.2 addresses some of the aircraft comparison problems. The data in Figure 2.2 contains only strategic flight events. Strategic flight events are only those events that any generic aircraft would need to maintain currency in order to get “from Point A to Point B”. No flight events that are associated with missions such as airdrop, weapons engagement, etc. are considered. This comparison will serve as a more useful “apples to apples” comparison.

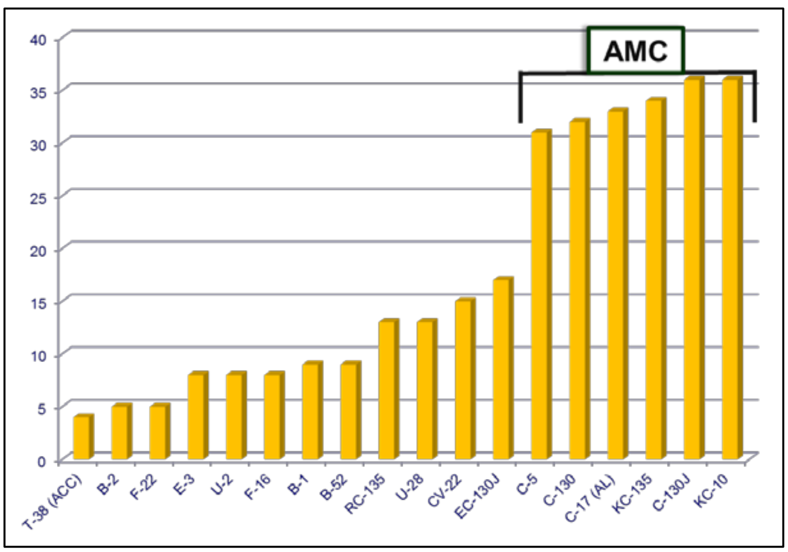

Figure 2.2 “Strategic” Flight Events by MDS (AFI 11-2MDS Volume 1, 2006-2012)

It is clear from Figure 2 that AMC continues to dominate the number of required flight currency events, even when analyzed at the MDS/airframe level. It is a further possible conclusion that number of currency items may simply be correlated to size of aircraft; that is to say, the larger the aircraft, the more currency items are necessary. To further solidify the comparison, Figure 2.3 identifies which aircraft are large frame aircraft. While all 6 aircraft types in the AMC section are large airframe, six of the sample large frame aircraft also belong to ACC's section of the graph. Therefore, it cannot be deduced that a large frame aircraft necessitates more currency flight events. Furthermore, Figure 2.4 highlights that identical basic airframes exist across the MAJCOM lines. In this case, the Boeing 707 airframe is the basic structure for the E-3, RC-135, and KC-135. It can be seen that ACC deems an E-3 pilot to be minimally safe with less than 10 currency items while it takes a KC-135 pilot in AMC more than 60 items to be minimally safe.

Aside from simply a numbers comparison, the impact on the combatant commander, our ultimate customer, must be investigated. For a typical ACC combat mission, the squadron has the flexibility to tailor virtually all of their training sorties to mimic the expected combat missions. For example, if an F-22 squadron is expected to deploy in order to provide the air component commander with air-to-ground strike capability, then that F-22 unit will spend the weeks leading up to the combat mission practicing air-to-ground strikes. The pilots may still accomplish their continuation training currency items, but because there are so few of them required, it does not hamper their aircraft time available to train for the expected combat role.

In contrast, an AMC squadron has less flexibility due to regulatory guidance. If a C-17 pilot is expected to be tasked with a combat mission or deployment to the Middle Eastern theater, only marginal ability exists to tailor training. The C-17 pilot may already be aware that the vast majority of approaches to landings expected on the deployment will be tactical approaches to visual or assault landings. However, the same pilot, while desiring to prepare for the actual combat scenario and be as proficient as possible in the expected events, is ultimately restricted to his currency items above all else. This pilot may be forced, by currency tables, to spend his flight time leading up to the combat mission completing relatively unnecessary events such as GPS or (Non-directional Beacon) NDB approaches, knowing full well that there are no GPS or NDB approaches anywhere in the combat theater, therefore extremely unlikely to be needed.

The conclusion to be gained from the MAJCOM comparisons above is that not all continuation training currency flight events that are currently in use by AMC are absolutely required for safe execution of a flying mission. Otherwise ACC aircraft would be experiencing aviation mishaps at a higher than acceptable rate. The next discussion will lead to weighing the more important and critical flight events in a quantitative manner to ensure that training allocation is effectively and efficiently accomplished.

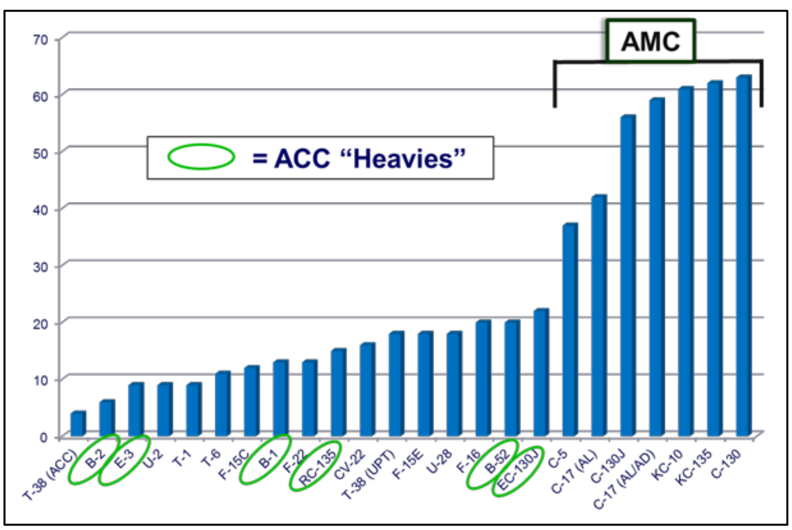

Figure 2.3 Total Flight Events by MDS (AFI 11-2MDS Volume 1, 2006-2012)

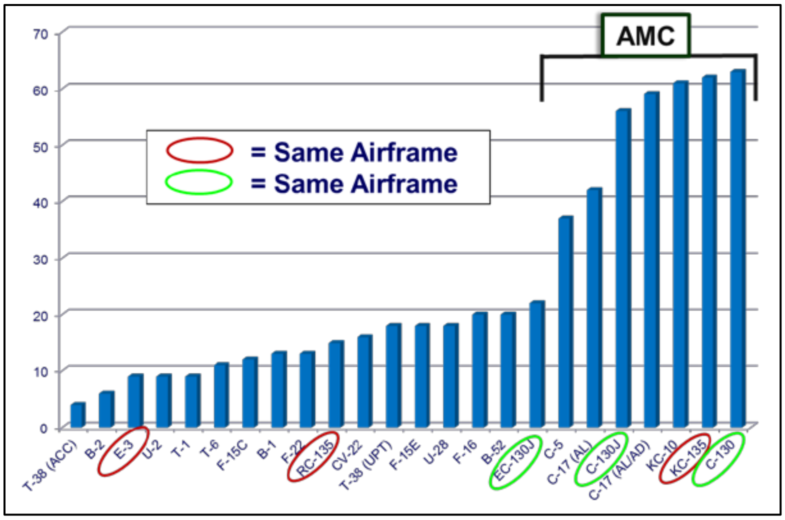

Figure 2.4 Total Flight Events by MDS (AFI 11-2MDS Volume 1, 2006-2012)

USAF Currency Requirements vs U.S. Airline Industry (Part 121)

U.S. Air Force flight currency programs differ from civil airlines' programs. The Federal Aviation Administration (FAA) began imposing minimum currency requirements in 1974, with a biannual flight review. (Catton, 2009) While the specific requirements of domestic airlines are a proprietary agreement between each airline and the FAA, the minimum number of flight requirements, even for like similar aircraft and mission sets, is substantially less in the airline sector than in the Air Force. As a regulatory minimum, Part 121 of the Federal Aviation Regulation mandates that no less than 3 takeoffs and landings in the previous 90 days must be accomplished for a pilot to serve as a required flight crewmember. For additional flexibility, the FAA has granted additional leeway with Part 121 airlines by accepting the substitution of proficiency checks for required recurrent flight training. (Federal Aviation Regulation, Part 121, 2015)

Weighted Flight Event System

In order to begin to analyze a quantifiable flight event system, scores must be allocated to each flight event based on applicable criteria. A C-17 pilot must maintain currency in twenty-eight flight events in order to remain on “current” status. Otherwise, he will be “non-current” and will be placed on a restrictive status until the events in which he went non-current for are completed with and instructor pilot (IP). (AFI 11-2C-17 Volume 1, 2012) Each event is treated equally important to maintain currency status and squadron leadership, who are charged with ensuring its pilot force remains current and ready to complete the missions assigned, have no authority or flexibility to consider the pilot in question’s entire situation before placing the pilot on restricted status.

For example, consider a senior aircraft commander that is scheduled to fly a high-importance operational mission. This pilot is flies an average of approximately 1-1.5 times per week and it is not uncommon to become non-current in a flight event once all normal attrition factors such as maintenance, weather, and TDYs are accounted for. In this scenario, squadron leadership has virtually no other option than to place the pilot on restricted status until he becomes re-current in the flight event that he went overdue for. The subsequent fall out of this scenario is potentially more impactful. Because the senior aircraft commander has gone non-current, squadron leadership has no choice but replace him with another aircraft commander on the high-importance mission. The replacement pilot could very well be a completely new and unexperienced but fully current junior aircraft commander. In effect, the squadron, not to mention the mission tasking authority, has lost out on all the depth and experience of the senior aircraft commander could have brought to the mission due to non-currency.

What is missing in the example above is the ability of the squadron to consider the senior pilot's entire situation before deeming him "non-current" and placing him on restricted status. For starters, the squadron leadership should know which event the pilot is non-current for and how "important" of an event it is based on quantifiable methods.

Data has been analyzed and constructed to apply quantitative scores to each of the twenty-eight flight events for an experienced C-17 aircraft commander. The current AFI 11-2C-17 volume one's minimum required flight event training table is listed below for an average aircraft commander:

		Aircraft Commander Currency Flight Level B (Mid-Level)		
		EVENT	QTY	Restriction
Per Semi Annual	1	DAY LOW LEVEL	1	Fly w/ IP
	2	PREC APPCH	4	Fly w/ IP
	3	NON-PREC APPCH	3	Fly w/ IP
	4	NDB APPCH	1	Fly w/ IP
	5	THREAT RESPONSE	2	Fly w/ IP
	6	HIGH ALT TAC	1	Fly w/ IP
	7	LOW ALT TAC	1	Fly w/ IP
	8	CAT II APPCH	1	Fly w/ IP
	9	RNAV APPCH	2	Fly w/ IP
	10	CIRCLE APPCH	2	Fly w/ IP
	11	MSN CPU APPCH	1	Fly w/ IP
	12	LNDG LZ NIGHT	1	Fly w/ IP
	13	HVY FF LDNG	2	Fly w/ IP
	14	HVY FF LDNG NT	1	Fly w/ IP
	15	NVG LOW LEVEL	1	Fly w/ IP
	16	NVG INST APPCH	1	Fly w/ IP
Per Quarter	17	TAC ARRIVAL	2	Fly w/ IP
	18	TAC DEPT	2	Fly w/ IP
	19	NT LANDING	2	Fly w/ IP
	20	LANDING LZ	2	Fly w/ IP
	21	NVG TAKEOFF	2	Fly w/ IP
	22	NVG LDG	1	Fly w/ IP
	23	RECEIVER AR AP OFF	2	Fly w/ IP
	24	RECEIVER AR NIGHT	2	Fly w/ IP
Per Month	25	TAKEOFF	1.6	Fly w/ IP
	26	INST. APPCH	1.6	Fly w/ IP
	27	LANDING	1	Fly w/ IP
Rolling	28	RECEIVER AR	1 per 60 days	Fly w/ IP

Table 2.1 Aircraft Commander Flight Level B Currency Requirements (AFI 11-2C-17 Volume 1, 2012)

Each of the above twenty-eight events was scored on three criteria categories: Complexity, Probability, and Impact. These category scores are used as the primary quantitative analysis tool to give a cumulative score for each flight event.

Probability-Impact Score

In the civilian market, a tool has been developed and polished over time to aid decision makers in the risk and insurance industry. The *Probability-Impact (PI) Scale, Score, or Table* is used to assign a quantifiable category, score, or stratification to a certain event, action, or inaction in order to provide decision makers with higher fidelity information. Probability is assessed as to the likelihood that an event will occur that will create a hazard. Impact is simply the magnitude of the resulting damage. The PI table allows a company or entity to decide which risk to accept, which risk to avoid, or which risk to insure.

The goal of risk management and the PI tool is not to avoid or eradicate all risk. This would be a practical impossibility in the real world. The goal of the PI tool, and of risk management, is to seek the most effective and cost efficient course to approach risk. In his book *Risk Analysis: A Quantitative Guide,* author David Vose explains that "the P-I table offers a quick way to visualize the importance of all identified risks that pertain to a project [or organization]". (Vose, 2008) The PI scoring system also provides the quantitative data to move the qualitative assessments of risk into highly adaptable and analyzable chart and graph formats. Vose goes on to highlight, "it is clearly important, however, that attention is focused on those risks that pose the greatest threat". This clarification underlines the notion that not all risk, and in the case of this research, events with risk, should be scored, treated, and restricted with the same weighting. The expertise in Vose's text would beg the C-17 training model to ensure it is critically judging each event and adjust the training planning and programming as necessary to provide the most efficient risk management model possible.

The PI tool only analyzes two aspects of risk: probability and impact. For the purposes of this research, the PI tool will be adjusted to include 3 aspects as they pertain to C-17 flight events. This research will focus on the complexity of an event, the probability of its occurrence, and the risk to the aircraft, people, and mission should the event not be correctly performed.

Skill Score (S_S)

Flight maneuvers have an associated level of complexity based on how difficult the maneuver is to complete. For the purposes of this research, the skill score is defined both by the level of skill required to complete the maneuver as well as how quickly the skill necessary to complete the maneuver diminishes. As it pertains to currency, the diminishment of a skill is the primary factor when determining how long between events before a pilot needs to re-accomplish the same event in order to remain minimally proficient. The Skill Score, when analyzed separately from the entire SPR Score, is an average score between two separate scores: Skill Required and Skill Diminishment Rate. In general, flight events that are more complex also have a higher skill diminishment rate. However, in order to capture higher fidelity data, two separates scores are obtained in order to calculate an average Skill Score that will be utilized in the total SPR Score. A flight event that takes a high degree of quickly diminishing skills is weighted with a higher Skill Score as compared to an event that takes a moderate level of slowly diminishing skills. Upon the completion of a given flight event, a pilot is assumed to be proficient at the minimally acceptable level to complete the mission.

Probability Score (S_P)

Each mission or training sortie is unique with its own set of objective, conditions, requirements, and personnel. Therefore, the flight events and their order for most sorties will not be identical to any other sortie. However, when the data is compiled over a large number of collections, patterns are identifiable and certain events are much more likely to occur than others on an average flight. Some events are less likely due to the resources and complexity of the coordination. Air refueling is a prime example. Air refueling sorties are significantly more expensive due to the added aircraft in the air at one time. Therefore, unless a requirement exists for air refueling, it is not seen on very many sorties as compared to a high occurrence event such as takeoffs and landings. Obviously, high occurrence events such as these will occur on every sortie and will therefore receive a high S_P Score.

Ideally, this research would be able to compile and quantify the historical averages of flight events over a statistically significant period of time. However, AMC does not currently collect data to analyze the exact occurrence rate for a given flight event. In the absence of this data, for this research, expert opinions will be sampled as to deduce approximate occurrence rate of a flight event relative to the occurrence rate of each of the other events.

Risk Score (S_R)

The nature of aviation means risk exists in any phase of flight. However, the Risk Score allows stratification amongst flight events that all have inherent risk. Risk models in the civilian sector assess risk with the intent to address the risk with one of three options: avoid, assume, or mitigate (insure) risk. The assumption for this research is that all flight events that are deemed necessary to maintain aircraft proficiency are at a risk level that is acceptable to absorb or mitigate. Again, air refueling is an example of a high risk event due to the fact that two aircraft are within feet of each other while traveling at a velocity of up to 400 nautical miles per hour. A small miscalculation or mistaken input of control can easily destroy two or more aircraft along with several crewmembers. An example of an event that results in a lower Risk Score would be one that either has multiple fail safes in place (either policy or technology placed), moves at a slow enough pace to allow for more time for the pilot to mentally process the situation.

Skill-Probability-Risk (SPR) Score

Once the data from the S_S, S_P, and S_R has been calculated, an SPR Score can be calculated. The SPR Score is a product of the individual four subcategories. This score will allow the necessary and appropriate weighting of the events to exist. This weighting is the primary factor in the final stratification of the events and their associated priority. “Landing LZ Night”, for example, ranks high on the skill, high on risk, but low on probability. Therefore, “Landing LZ Night” events received a higher SPR Score than “Takeoff”, which scored very low on skill, but very high on probability, and moderately low on risk. The SPR score is calculated for each of the twenty-eight flight events which will result in a 1 through n rank structure. This simple calculation is a major step forward for squadron leadership. This calculation now give squadrons quantifiable data on which to make further and higher fidelity decisions as it pertains to their pilot force's actual currency status.

Current Methods in Quantitative Aviation Risk Analysis

The civilian aviation industry, specifically the FAA, has made safety and risk management an official program of record since the 1960s. The FAA is the leader in aviation safety, risk, and risk management fields. The US Air Force's safety programs are largely derived from these. Aviation quantitative risk analysis (QRA) is similar to the P-I index mentioned above, and attempts to collect subjective assessments of exposure to risk probability and risk severity, then to subsequently quantify the total risk exposure to the aviation event. The FAA has developed an aviation risk assessment matrix that provides flight planners and pilots with the current method of quantifying flight risk in to categorical results of acceptable, acceptable with mitigation, and unacceptable.

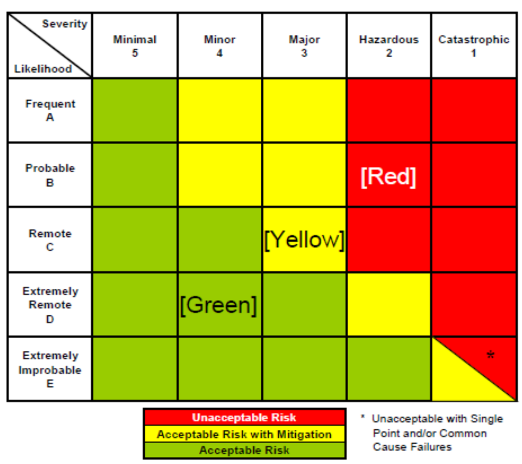

Figure 2.5 FAA Safety Risk Management Matrix (FAA, 2012)

Thus far, aviation risk assessments have been focused on general flight versus training events. This approach of QRA is the basis for the methodology in this paper of the SPR Score. SPR is a continuation of the QRA matrix, but adds and uses the numerical score of each event to prioritize all C-17 flight events verses the current method of risk categorization. Human perception is the foundation to the FAA's QRA program. (FAA, Flight Instructor Training Module, Version 1.0) Likewise, the SPR Score is a factor of human perception toward a training flight event's subcategories. Furthermore, the FAA cites pilot recency of experience as a mitigating factor when addressing aviation risk. (FAA, Flight Instructor Training Module, Version 1.0) Therefore, a natural research progression, and a purpose of this paper is to help work toward the goal of understanding how much recency is required by a C-17 pilot in order to mitigate the flight event's inherent risk, based on the SPR subcategories and the flight event's overall relative priority score.

III. Methodology

Chapter Overview

This paper utilized several mathematical computations in order to calculate a resulting SPR Score. Interviews with several C-17 mission and flight training experts have provided the sufficient data to the research in order to calculate relative and quantifiable scores based on a given category, to include skill, probability and risk.

Sample Pool

Assigning a quantifiable score to each flight event relies heavily upon subjective perceptions from each interviewee. In order to obtain credible, quantifiable data, a sample size that was large enough to reasonably derive statistical averages was chosen. This research interviewed eight C-17 evaluator pilots. The average flight time of the pool is just over 2700 hours. All interviewees were C-17 only pilots, with seven being evaluator pilots and one senior instructor pilot. That is, none of the interviewees have flown additional MDS aircraft in their operational careers outside of pilot training. Overall, the sample size of the interviewees was relatively small when compared to larger research, however, the sample pool was specifically chosen due to their expertise in the aircraft. The depth of experience and knowledge in the sample pool negates the need for a large sample. Finally, because human research was utilized, an exemption to human experimentation was sought and approved in accordance with 32 CFR 219, DoDD 3216.2 and AFI 40-402.

Interview Score Sheet

The only way to quantify each flight event is to assign some form of numerical score to each item. In this research, each interviewee was given a sheet with each of the 28 C-17 flight events. The events were listed vertically in the specific order that they are listed in the Vol 1 as to not mistakenly communicate any inherent or perceived pre-ranking or grouping among the events on the score sheet. Each interviewee was given instructions to individually rank each item 1 through 28, with the lower scores indicative of the most skill required (S), the highest probability (P), and the most risk involved (R). Once the sheet was ranked by the interviewee, an associated score was calculated to each flight event. For example, if an event was ranked the #1 priority in that field, it was assigned the maximum score of 28 points. Conversely, the #28 ranked event received a calculated score of 1 point for that category. This ranking was completed for 4 categories: Skill Required, Skill Diminishment Rate, Probability of Occurrence, and Risk.

SKILL REQUIRED TO COMPLETE		
YOUR RANKING	SCORE	EVENT
		DAY LOW LEVEL
		PRECISION APPCH
		NON-PREC APPCH
		NDB APPCH
		THREAT RESPONSE
		HIGH ALT TAC
		LOW ALT TAC
		CAT II APPCH
		RNAV APPCH
		CIRCLE APPCH
		MSN CPU APPCH
		LNDG LZ NIGHT
		HVY FF LDNG
		HVY FF LDNG NT
		NVG LOW LEVEL
		NVG INST APPCH
		NVG LZ
		TAC DEPT
		NT LANDING
		LANDING LZ
		NVG TAKEOFF
		NVG LDG
		RECEIVER AR AP OFF
		RECEIVER AR NIGHT
		TAKEOFF
		INST. APPCH
		LANDING
		RECEIVER AR

SKILL DIMINISHMENT RATE		
YOUR RANKING	SCORE	EVENT
		DAY LOW LEVEL
		PRECISION APPCH
		NON-PREC APPCH
		NDB APPCH
		THREAT RESPONSE
		HIGH ALT TAC
		LOW ALT TAC
		CAT II APPCH
		RNAV APPCH
		CIRCLE APPCH
		MSN CPU APPCH
		LNDG LZ NIGHT
		HVY FF LDNG
		HVY FF LDNG NT
		NVG LOW LEVEL
		NVG INST APPCH
		NVG LZ
		TAC DEPT
		NT LANDING
		LANDING LZ
		NVG TAKEOFF
		NVG LDG
		RECEIVER AR AP OFF
		RECEIVER AR NIGHT
		TAKEOFF
		INST. APPCH
		LANDING
		RECEIVER AR

Table 3.1 Skill Score Sheet

PROBABILTY OF OCCURRENCE		
YOUR RANKING	SCORE	EVENT
		DAY LOW LEVEL
		PRECISION APPCH
		NON-PREC APPCH
		NDB APPCH
		THREAT RESPONSE
		HIGH ALT TAC
		LOW ALT TAC
		CAT II APPCH
		RNAV APPCH
		CIRCLE APPCH
		MSN CPU APPCH
		LNDG LZ NIGHT
		HVY FF LDNG
		HVY FF LDNG NT
		NVG LOW LEVEL
		NVG INST APPCH
		NVG LZ
		TAC DEPT
		NT LANDING
		LANDING LZ
		NVG TAKEOFF
		NVG LDG
		RECEIVER AR AP OFF
		RECEIVER AR NIGHT
		TAKEOFF
		INST. APPCH
		LANDING
		RECEIVER AR

RISK IF NOT PERFORMED CORRECTLY		
YOUR RANKING	SCORE	EVENT
		DAY LOW LEVEL
		PRECISION APPCH
		NON-PREC APPCH
		NDB APPCH
		THREAT RESPONSE
		HIGH ALT TAC
		LOW ALT TAC
		CAT II APPCH
		RNAV APPCH
		CIRCLE APPCH
		MSN CPU APPCH
		LNDG LZ NIGHT
		HVY FF LDNG
		HVY FF LDNG NT
		NVG LOW LEVEL
		NVG INST APPCH
		NVG LZ
		TAC DEPT
		NT LANDING
		LANDING LZ
		NVG TAKEOFF
		NVG LDG
		RECEIVER AR AP OFF
		RECEIVER AR NIGHT
		TAKEOFF
		INST. APPCH
		LANDING
		RECEIVER AR

Table 3.2 Probability and Risk Score Sheets

SPR Calculation

The SPR Score can be calculated via two similar, but distinguishable methods. Method 1 uses a sum total of all sub-scores to rank the events by total overall score. Method 2 uses a product of all sub-scores to rank the events by total overall score. This research will discuss and compare any ranking discrepancies between the two methods, but for the purposes of conclusion and recommendation, Method 2 is the preferred analysis method.

The SPR Score (Method 2 unless otherwise stated) can be calculated via the following method:

$$SPR = (S_S \text{ x } S_P \text{ x } S_R) \text{ x } 100$$

Equation 3.1 SPR Score Calculation

Each sub-category (SS, SP, and SR, are averages of the subcategory's score based on the total score assigned by the interviewees. For example, if the eight interviewees scored an event 9, 8,8,4,7,8,9,7 respectively, then the total average score for that event would be 7.5. That sub-score would then be multiplied by the sub-scores from each of the other four categories. That product would then be multiplied by 100 for ease of use. Once the product is calculated for each flight event, all 28 events are rank ordered from highest score to lowest score for analysis.

EXAMPLE: The "DAY LOW LEVEL" event received the following average scores out of a maximum of 224 (28 points x 8 interviewees):

Skill Required: 126
Skill Diminishment Rate: 136

Probability: 49
Risk: 166

Next, the average score was divided by 224 to get the percentile of the score to determine how strong the score is. The closer to a 1.0 percentile score, the stronger the score is. The following percentiles are for "DAY LOW LEVEL"

Skill Required: .5625
Skill Diminishment Rate: .61
Probability: .22
Risk: .74

To obtain a final SPR score, each category is multiplied be each other, and then multiplied by 100for ease of use. The maximum theoretical possible score is 100.

(.5625 x .61 x .22 x .74) x 100 = 5.54 SPR Score

To obtain a ranking, aka "RANK", the SPR Scores are arranged from highest to lowest to calculate the associated ranking. The highest SPR Score receives a rank of 1, and the lowest SPR Score receives a rank of 28. For some of the comparison in the analysis section, a ranking was converted to a "RANK-SCORE". This is calculated by subtracting the "RANK" from a value of 29. Therefore, a "RANK" of 1 would have an associated "RANK-SCORE" of 28; the maximum possible value.

IV. Analysis and Results

Chapter Overview

The data collection from the interviewees allows qualitative subjectivity to be quantified and stratified. The data allows the research to compare and contrast the expert-supplied data with that from the Vol 1's training tables. The data was stratified based on relative importance; those events that scored highest on the SPR score are deemed to be more important based on the expert opinion.

Skill Required

Each event was ranked based on the skill required for the event by the expert panel. A flight event that requires a large amount of skill will be ranked relatively high (low numerical ranking), and will have a relatively high associated score. The following table shows the flight event ranking and score totals, in descending order. The maximum possible rank or score is 224 and the theoretical maximum percentile is 1.00:

SKILL REQUIRED			
RANK	SCORE	PERCENTILE	EVENT
16	216	0.9643	RECEIVER AR AP OFF
16	216	0.9643	RECEIVER AR NIGHT
31	201	0.8973	NVG LZ
36	196	0.8750	RECEIVER AR
43	189	0.8438	LNDG LZ NIGHT
49	183	0.8170	LANDING LZ
73	159	0.7098	HVY FF LDNG NT
88	144	0.6429	HIGH ALT TAC
93	139	0.6205	HVY FF LDNG
93	139	0.6205	NVG LDG
98	134	0.5982	LOW ALT TAC
104	128	0.5714	NVG LOW LEVEL
106	126	0.5625	DAY LOW LEVEL
124	108	0.4821	CIRCLE APPCH
127	105	0.4688	NT LANDING
138	94	0.4196	NVG TAKEOFF
140	92	0.4107	NDB APPCH
149	83	0.3705	TAC DEPT
151	81	0.3616	NVG INST APPCH
152	80	0.3571	THREAT RESPONSE
155	77	0.3438	CAT II APPCH
163	69	0.3080	LANDING
168	64	0.2857	MSN CPU APPCH
171	61	0.2723	NON-PREC APPCH
173	59	0.2634	RNAV APPCH
194	38	0.1696	INST. APPCH
198	34	0.1518	PRECISION APPCH
199	33	0.1473	TAKEOFF

Table 4.1 Skill Required Score Results

Skill Diminishment Rate

Each event was ranked based on the rate in which the skills required diminish over time. A flight event that has a relatively quick skill diminishment rate will be ranked relatively high (low numerical ranking), and will have a relatively high associated score. The following table shows the flight event ranking and score totals in descending order. The maximum possible rank or score is 224 and the theoretical maximum percentile is 1.00:

SKILL DIMINISH			
RANK	SCORE	PERCENTILE	EVENT
12	220	0.98	RECEIVER AR AP OFF
16	216	0.96	RECEIVER AR NIGHT
29	203	0.91	RECEIVER AR
31	201	0.90	NVG LZ
44	188	0.84	LNDG LZ NIGHT
50	182	0.81	LANDING LZ
82	150	0.67	HVY FF LDNG NT
91	141	0.63	NVG LDG
96	136	0.61	DAY LOW LEVEL
97	135	0.60	HIGH ALT TAC
100	132	0.59	HVY FF LDNG
101	131	0.58	LOW ALT TAC
102	130	0.58	NVG LOW LEVEL
118	114	0.51	NT LANDING
126	106	0.47	CIRCLE APPCH
136	96	0.43	NVG TAKEOFF
140	92	0.41	THREAT RESPONSE
141	91	0.41	TAC DEPT
148	84	0.38	NDB APPCH
154	78	0.35	MSN CPU APPCH
154	78	0.35	NVG INST APPCH
154	78	0.35	LANDING
168	64	0.29	NON-PREC APPCH
170	62	0.28	RNAV APPCH
180	52	0.23	CAT II APPCH
194	38	0.17	TAKEOFF
197	35	0.16	INST. APPCH
206	26	0.12	PRECISION APPCH

Table 4.2 Skill Diminishment Rate Score Results

Probability of Occurrence

Each event was ranked based on the probability that the event will be required for mission accomplishment on any given flight. Expert interviewees did not account for those events that are completed solely for the purpose of fulfilling Vol 1 requirements. A flight event that has a relatively high probability will be ranked relatively high (low numerical ranking), and will have a relatively high associated score. The following table shows the flight event ranking and score totals in descending order.

The maximum possible rank or score is 224 and the theoretical maximum percentile is 1.00:

PROB OF OCCURRENCE			
RANK	SCORE	PERCENTILE	EVENT
11	221	0.99	TAKEOFF
15	217	0.97	LANDING
31	201	0.90	PRECISION APPCH
33	199	0.89	INST. APPCH
50	182	0.81	NON-PREC APPCH
61	171	0.76	NT LANDING
94	138	0.62	LOW ALT TAC
98	134	0.60	RNAV APPCH
100	132	0.59	CAT II APPCH
101	131	0.58	NVG LDG
103	129	0.58	HVY FF LDNG
104	128	0.57	NVG TAKEOFF
106	126	0.56	HIGH ALT TAC
106	126	0.56	TAC DEPT
119	113	0.50	CIRCLE APPCH
120	112	0.50	HVY FF LDNG NT
144	88	0.39	THREAT RESPONSE
145	87	0.39	MSN CPU APPCH
146	86	0.38	RECEIVER AR
152	80	0.36	NVG INST APPCH
159	73	0.33	LANDING LZ
162	70	0.31	RECEIVER AR NIGHT
163	69	0.31	LNDG LZ NIGHT
180	52	0.23	NVG LZ
180	52	0.23	RECEIVER AR AP OFF
183	49	0.22	DAY LOW LEVEL
186	46	0.21	NDB APPCH
196	36	0.16	NVG LOW LEVEL

Table 4.3 Probability Score Results

Risk

Each event was ranked based on the inherent risk associated with the event if the maneuver is not performed correctly. This category acknowledges that in any flight event, the risk of death and aircraft loss is possible. Therefore, events that have fewer redundancies or time to react, for example, are considered more risky than others. A flight event that has relatively risk will be ranked relatively high (low numerical ranking), and will have a relatively high associated score. The following table shows the flight event ranking and score totals in descending order. The maximum possible rank or score is 224 and the theoretical maximum percentile is 1.00:

RISK			
RANK	SCORE	PERCENTILE	EVENT
26	206	0.92	RECEIVER AR AP OFF
26	206	0.92	RECEIVER AR NIGHT
38	194	0.87	NVG LZ
40	192	0.86	RECEIVER AR
44	188	0.84	LNDG LZ NIGHT
58	174	0.78	LANDING LZ
62	170	0.76	HVY FF LDNG NT
66	166	0.74	DAY LOW LEVEL
83	149	0.67	NVG LDG
86	146	0.65	NVG LOW LEVEL
90	142	0.63	HVY FF LDNG
104	128	0.57	THREAT RESPONSE
106	126	0.56	NT LANDING
121	111	0.50	NVG TAKEOFF
130	102	0.46	LANDING
133	99	0.44	LOW ALT TAC
143	89	0.40	TAKEOFF
150	82	0.37	NVG INST APPCH
150	82	0.37	TAC DEPT
154	78	0.35	CAT II APPCH
160	72	0.32	HIGH ALT TAC
164	68	0.30	CIRCLE APPCH
177	55	0.25	NDB APPCH
181	51	0.23	RNAV APPCH
183	49	0.22	MSN CPU APPCH
187	45	0.20	PRECISION APPCH
192	40	0.18	NON-PREC APPCH
194	38	0.17	INST. APPCH

Table 4.4 Risk Score Results

Cross-Comparison of SPR Sub-Scores

When each sub-category is analyzed individually, it produces a relatively linear pattern of scores ranging from the high .9's range to the low .1's range. Each category does not communicate very much information until it is compared with the other sub-categories amidst the backdrop of the SPR Percentile Ranking. Figure 4.5 illustrates all 4 sub-categories when ranked in the SPR ranking based on percentile.

Interestingly, Skill required, Skill Diminish Rate, and Risk sub-categories demonstrate a linear relationship when compared to SPR score, as well as they are clearly associated with each other. Probability, on the other hand, demonstrates no relationship with SPR score.

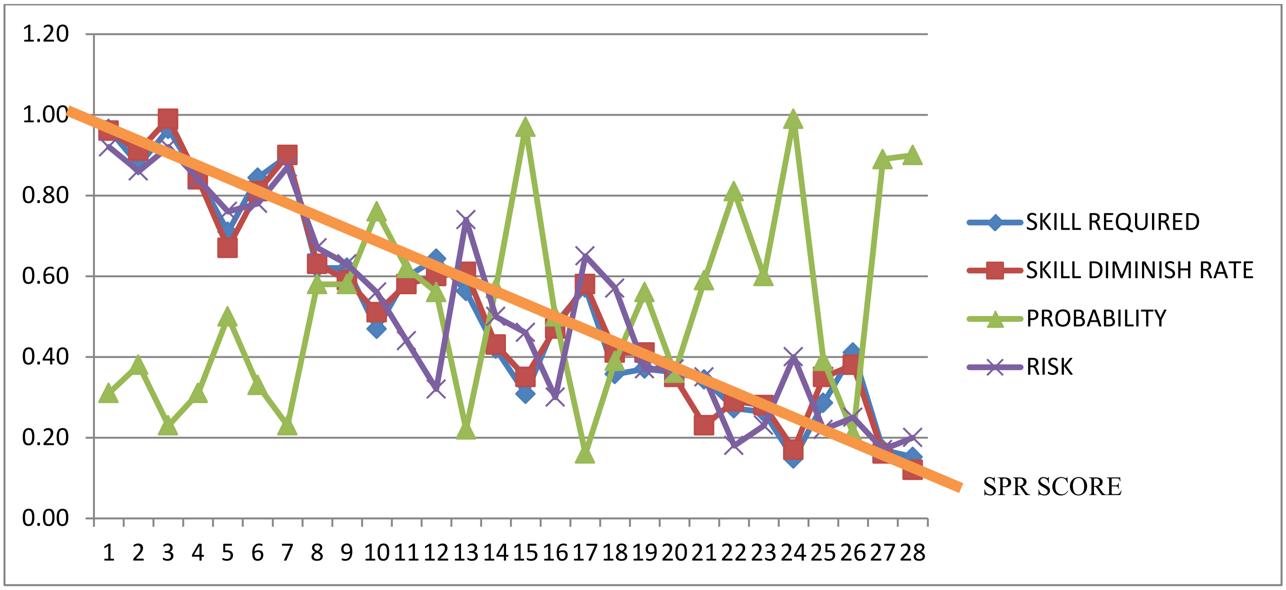

Figure 4.1Cross Comparison of Skill, Probability, and Risk Scores

SPR Score

Once the subcategories were tallied, an SPR score was calculated in order to rank all 28 events by percentile score. The ranking is listed in figure 4. 6 below. Figure 4. X illustrates the events' SPR score values on a plotting chart. This chart is important because it highlights any relationships among the scores relative to each other. From this chart it can be viewed that all 28 events scored in 1 of 3 distinct groupings . For the purpose of this research, the 3 groups, or categories, will be "High", "Medium", and "Low". High events are those that scored above 20 points. Medium events are between 6 and 20 points. Low events scored below 6 points.

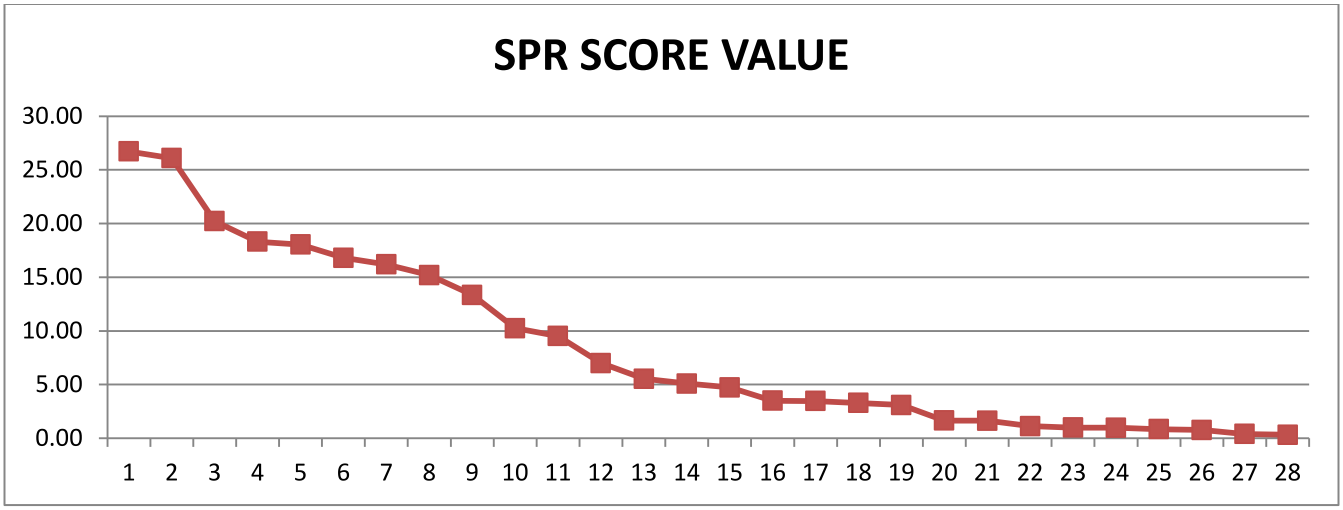

Figure 4.2 SPR Score Value

RANK	SPR SCORE	EVENT
1	26.72	RECEIVER AR NIGHT
2	26.10	RECEIVER AR
3	20.22	RECEIVER AR AP OFF
4	18.31	LNDG LZ NIGHT
5	18.04	HVY FF LDNG NT
6	16.80	LANDING LZ
7	16.19	NVG LZ
8	15.19	NVG LDG
9	13.35	HVY FF LDNG
10	10.24	NT LANDING
11	9.53	LOW ALT TAC
12	7.00	HIGH ALT TAC
13	5.54	DAY LOW LEVEL
14	5.09	NVG TAKEOFF
15	4.73	LANDING
16	3.49	CIRCLE APPCH
17	3.47	NVG LOW LEVEL
18	3.29	THREAT RESPONSE
19	3.10	TAC DEPT
20	1.65	NVG INST APPCH
21	1.64	CAT II APPCH
22	1.13	NON-PREC APPCH
23	0.99	RNAV APPCH
24	0.98	TAKEOFF
25	0.85	MSN CPU APPCH
26	0.78	NDB APPCH
27	0.40	INST. APPCH
28	0.32	PRECISION APPCH

Table 4.5 Events Ranked by SPR Score

SPR Rank-Score vs Vol 1 Rank-Score

By analyzing the data points, it is clear to see that there are significant discrepancies between the SPR Rank-Score and the Vol 1 Rank-Score. Figure 4.8 illustrates the differences in scores between the two processes. Ideally, the two score sets would be much more highly aligned with each other. Events that the SPR data deemed the most important (upper left of the chart) were scored equally unimportant by Vol 1 standards. Similarly, events that were scored very low by SPR data were conversely scored very high by Vol 1 tables. The extreme lower left and extreme upper right of the chart are areas of major discrepancy between the two processes and potentially provide the areas most ripe for reconciliation.

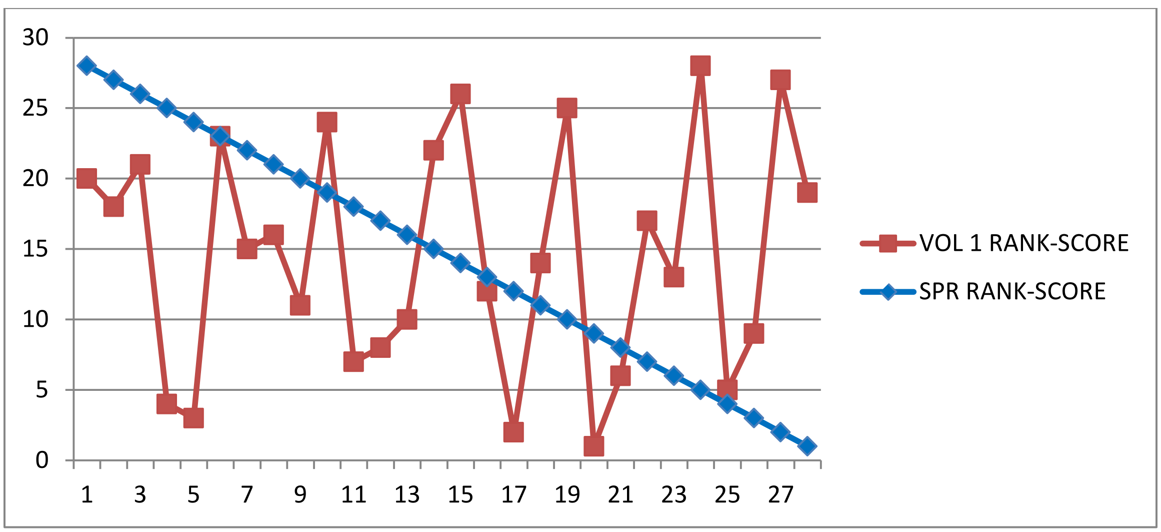

Figure 4.3 SPR Rank-Score vs Vol 1 Rank-Score

Figure 4.9 below summarizes the scoring associated with each flight event. Take note that the SPR score and the Vol 1 scores are not on the same scale, therefore cannot be directly compared. This is the basis for the Rank-Score scale used above.

$$\frac{\text{Maximum Number of Days in Applicable Currency Period}}{\text{Minimum Number of Events Required in Period}}$$

* Lower Vol 1 Calculation score indicates a higher Vol 1 priority

Equation 4.1 Vol 1 Score Calculation

Event	SPR Score	VOL 1 Score	Skill Req	Skill Dim	Prob	Risk
RECEIVER AR NIGHT	26.40	2.27273	0.96	0.96	0.31	0.92
RECEIVER AR	26.02	1.72414	0.88	0.91	0.38	0.86
RECEIVER AR AP OFF	20.20	2.27273	0.96	0.99	0.23	0.92
LNDG LZ NIGHT	18.46	0.56180	0.84	0.84	0.31	0.84
HVY FF LDNG NT	18.07	0.56180	0.71	0.67	0.50	0.76
LANDING LZ	17.59	2.27273	0.84	0.81	0.33	0.78
NVG LZ	16.16	1.13636	0.90	0.90	0.23	0.87
NVG LDG	15.19	1.13636	0.62	0.63	0.58	0.67
HVY FF LDNG	13.38	1.12360	0.62	0.59	0.58	0.63
NT LANDING	10.18	2.27273	0.47	0.51	0.76	0.56
LOW ALT TAC	9.46	0.56180	0.60	0.58	0.62	0.44
HIGH ALT TAC	6.91	0.56180	0.64	0.60	0.56	0.32
DAY LOW LEVEL	5.59	0.56180	0.56	0.61	0.22	0.74
NVG TAKEOFF	5.14	2.27273	0.42	0.43	0.57	0.50
LANDING	4.81	3.57143	0.31	0.35	0.97	0.46
CIRCLE APPCH	3.40	1.12360	0.48	0.47	0.50	0.30
NVG LOW LEVEL	3.45	0.56180	0.57	0.58	0.16	0.65
THREAT RESPONSE	3.25	1.12360	0.36	0.41	0.39	0.57
TAC DEPT	3.15	2.27273	0.37	0.41	0.56	0.37
NVG INST APPCH	1.69	0.56180	0.36	0.35	0.36	0.37
CAT II APPCH	1.63	0.56180	0.34	0.23	0.59	0.35
NON-PREC APPCH	1.15	1.68539	0.27	0.29	0.81	0.18
RNAV APPCH	1.02	1.12360	0.26	0.28	0.60	0.23
TAKEOFF	0.99	5.71429	0.15	0.17	0.99	0.40
MSN CPU APPCH	0.86	0.56180	0.29	0.35	0.39	0.22
NDB APPCH	0.82	0.56180	0.41	0.38	0.21	0.25
INST. APPCH	0.41	5.71429	0.17	0.16	0.89	0.17
PRECISION APPCH	0.33	2.24719	0.15	0.12	0.90	0.20

Table 4.6 Event Score Summary

Investigative Questions Answered

What is the current AMC C-17 training model?

It has been established that the current AMC C-17 training model is solely based on currency for each of the 28 selected events. While it is unclear exactly how the number of event repetitions per time period was originally composed, this research provides leadership with high-fidelity and quantifiable data on which to create training tables that more appropriately align with the skill, probability, and risk associated with each event.

How does it compare to the rest of the Air Force MDSs?

The C-17 training model is in line with the whole of AMC's training model. AMC has been shown to require substantially more flight events per time period than the rest of the operational Air Force. The SPR data can be the first step in better prioritizing training events so that valuable time and resources can be better allocated to the appropriate flight events.

How do USAF currency requirements differ from U.S. civilian airlines?

The FAA establishes the minimum number of events within a given time period for U.S. Airlines in the Federal Aviation Regulation (FAR) Section 121. The FAR's minimums are substantially less than that of any AMC Volume 1. The FAR's only recency requirement is for a pilot to accomplish 3 takeoffs and 3 landings within the preceding 90 days. This equates to 12 flight events per 180 days, which is the AMC standard period for its Volume 1 regulations. All AMC aircraft have between 31 and 36 flight events, not including “mission” flight events (tactical maneuvers, airdrop, etc.) in the same period. (AFI 11-2MDS Volume 1, 2006-2012) This equates to AMC pilots being responsible for 300% of the like events that airline pilots are required to perform. If “mission” events are included, AMC pilots are required to complete as much as 600% of those required of airline pilots. (AFI 11-2MDS Volume 1, 2006-2012)

Are all C-17 flight events equal?

Even though the Vol 1 perceives all C-17 flight events as being equal in importance with respect to currency status, the SPR results argue that the qualitative data provided by the expert interviews indicate that the events are far from equal and should be addressed as such when developing training plans and assessing currency or proficiency.

Can C-17 training events be quantified and stratified?

This research has concluded that C-17 training events can be quantified and stratified. While the SPR model is only one approach to the process, it demonstrates that qualitative information from the experts in the C-17 pilot force can be collected and quantified to provide useful tools to the commander and AMC leadership.

What flexibility is gained at the squadron, group, and MAJCOM level?

This research has given AMC leadership a significant opportunity to empower squadrons, relieve the pilot force of relatively unnecessary but restrictive flight events, and save the Air Force valuable flight and man hours.

Not to be outdone, this process can provide the Combatant Commander with more proficient and higher caliber pilots at a reduced cost.

Feasibility (Hammer, M. and Champy, J., 2001)

a. Technical – This data can be easily used or the process replicated on a large scale. Additionally, this research only amplifies the abilities and decision making of AMC leadership by providing the stratified priority based on actual expert data. The overall process can easily be implemented by AMC

b. Economic – There is relatively no costs to replicate or implement this process or program.

c. Cultural – Due to the argument that this research can birth a program that empowers squadrons, reduces costs, reduces restrictions on pilots, and provides a better product to the fight, no pushback can be predicted based on the results of this research.

V. Conclusions and Recommendations

Chapter Overview

The research and subsequent data from this paper can provide a significant impact to the C-17 training model. This chapter will focus on the effects, improvements, and savings that can be generated should this data and its recommendations be utilized. Fiscal realities within the Department of Defense are forcing Airmen to seek out new and innovative ways to reduce costs and improve productivity within a smaller and smaller force.

Conclusions of Research

The conclusion of this research is that qualitative and subjective data from a significant sample set can provide a quantitative means to analyze and apply C-17 training events. Under the current model, the Vol 1 and the experts in this research are in a significant disagreement between which training events are most important based on required skill, probability of the event occurring on a mission, and the risk if the event is not performed correctly.

Furthermore, this research highlights relatively drastic differences between MAJCOMs when determining the minimum currency training events for a pilot. AMC requires significantly more currency events in a training period than that of ACC and AFSOC, even among like airframes.

Significance of Research

In practice, this research and its implementation are relatively simple; simple in calculation, administration, as well as execution. For the first time ever, AMC now has quantifiable and stratifiable means to assess and administer its training events.

As mentioned before, currently, all training events are treated as equally important with respect to currency. A pilot that is non-current for "Receiver AR Night", which was ranked the most important via SPR Score, is just as ineligible to fly a mission as the pilot that is non-current for precision approach, which is ranked as least important based on SPR Score. Under current regulations, this pilot, even though he may be the most experienced and capable pilot in the squadron is not legally permitted to complete this mission. The Vol 1 does allow the Operations Group Commander, an O-6, waiver authority for the currency item. This policy does not provide any guidance for AMC's intent on when or how the waiver process is intended to be executed.

Should this model be used, it is possible for AMC to determine a threshold of authority in which squadrons and groups have clear guidance on what can be waived, by which level of authority, and how often it should be waived. For example, if we remain with the simplified High, Medium, and Low classes of events as was mentioned earlier, it is feasible for AMC to delegate waiver authority for Low category events to Squadron Commander, perhaps Medium category waiver authority to the Operations Group Commander, and High category events are only waiverable by MAJCOM. Squadron commanders could then look at the pilot more holistically when determining if the pilot should receive the waiver. If the pilot happens to be a highly experienced evaluator pilot with 3500 hours in the C-17, it makes complete sense to waive an NDB approach non-currency status so that the pilot can fill a mission for a Combatant Commander, or fill a high-priority alert to move the President's equipment and personnel for a high-impact political summit.

Additionally, cost savings possibilities are abundant. First, the pilot that receives a waiver immediately realizes cost savings by not having to fly additional training hours to regain currency. Additional instructor pilot man-hours are not wasted by supervising a highly capable pilot regain the currency on an item that scored very low on the SPR Score, therefore may be a relatively unimpactful flight event.

In the future, it could be highly beneficial for AMC to recognize those flight events that are relatively unimportant for currency and could be removed from the currency table. This could lead AMC's training tables to more closely mirror those in the rest of the operational flying Air Force. Reducing training events will clearly reduce costs associated with those training sorties that are solely generated to maintain or regain currency. Those flight hours could be harvested for savings, or possibly administered in a training plan that will increase proficiency and capability in flight events that are deemed necessary by the squadron training office or leadership.

In summary, the model that this research makes possible reduces costs, increases capability, reduces overhead, and reduces man hours.

Recommendations for Action

It is recommended that the training model that this research allows and recommends be reviewed by AMC. Additionally, a pilot program should be established at a C-17 Wing in order to study the effects of such a program on the squadron. These results will assist in determining whether the program be adjusted or administered AMC-wide.

Recommendations for Future Research

This research allows a training model that opens up future possibilities. There are several suggestions for future research based on the data collected in this thesis:

1. Conduct similar studies in other AMC airframes to determine if the discrepancy between the Vol 1 and the expert judgement is limited to the C-17.

2. Conduct studies of ACC flying units to determine what best practices and efficiencies could be gained by AMC by adjusting a training model more aligned with CAF units.

3. Utilize the quantitative data from this or follow-on studies to develop an optimization tool that could be used by squadrons to ensure the highest priority pilots are flying the most appropriate training lines, while conducting the highest priority flight events that will most support the Combatant Commander.

Summary

In conclusion, AMC currently maintains a training model for the C-17 that does a remarkable job at ensuring that every pilot that flies a mission has completed at least a minimum number of flight events within a given period. This model has worked very well at exposing each pilot to a myriad of events that he could face while on the mission to a seemingly limitless number of airfields and environments.

However, this research demonstrates a possible surplus in training events by AMC units when compared to their CAF counterparts who are also deemed safe and equipped to fly. Additionally, this research provides the means to quantify expert subjective opinion that can either support or challenge the training model and tables that are provided in regulatory guidance, specifically the 11-2MDS Volume 1.

The quantitative data collected in this research has highlighted significant discrepancies between expert opinion and Vol 1 guidance regarding the relative significance of each of 28 selected strategic flight events. These discrepancies warrant at least further investigation if not full implementation resulting in a major overhaul in the C-17 training program which could easily result in major cost savings and capability increases.

Appendix A

SPR		
RANK	SCORE	EVENT
1	28	RECEIVER AR NIGHT
2	27	RECEIVER AR
3	26	RECEIVER AR AP OFF
4	25	LNDG LZ NIGHT
5	24	HVY FF LDNG NT
6	23	LANDING LZ
7	22	NVG LZ
8	21	NVG LDG
9	20	HVY FF LDNG
10	19	NT LANDING
11	18	LOW ALT TAC
12	17	HIGH ALT TAC
13	16	DAY LOW LEVEL
14	15	NVG TAKEOFF
15	14	LANDING
16	13	CIRCLE APPCH
17	12	NVG LOW LEVEL
18	11	THREAT RESPONSE
19	10	TAC DEPT
20	9	NVG INST APPCH
21	8	CAT II APPCH
22	7	NON-PREC APPCH
23	6	RNAV APPCH
24	5	TAKEOFF
25	4	MSN CPU APPCH
26	3	NDB APPCH
27	2	INST. APPCH
28	1	PRECISION APPCH

VOLUME 1		
RANK	SCORE	EVENT
1	28	TAKEOFF
2	27	INST. APPCH
3	26	LANDING
4	25	TAC DEPT
5	24	NT LANDING
6	23	LANDING LZ
7	22	NVG TAKEOFF
8	21	RECEIVER AR AP OFF
9	20	RECEIVER AR NIGHT
10	19	PREC APPCH
11	18	RECEIVER AR
12	17	NON-PREC APPCH
13	16	NVG LDG
14	15	NVG LZ
15	14	THREAT RESPONSE
16	13	RNAV APPCH
17	12	CIRCLE APPCH
18	11	HVY FF LDNG
19	10	DAY LOW LEVEL
20	9	NDB APPCH
21	8	HIGH ALT TAC
22	7	LOW ALT TAC
23	6	CAT II APPCH
24	5	MSN CPU APPCH
25	4	LNDG LZ NIGHT
26	3	HVY FF LDNG NT
27	2	NVG LOW LEVEL
28	1	NVG INST APPCH

Table A.1 SPR Rank vs. Vol 1 Rank

Appendix B

SKILL REQUIRED SCORE									
EVENT	A	B	C	D	E	F	G	H	AVG
RECEIVER AR AP OFF	26	28	27	28	27	28	24	28	27.00
RECEIVER AR NIGHT	27	27	28	27	28	27	25	27	27.00
NVG LZ	25	26	25	25	24	25	27	24	25.13
RECEIVER AR	28	24	26	26	26	26	15	25	24.50
LNDG LZ NIGHT	24	25	23	24	25	14	28	26	23.63
LANDING LZ	23	22	24	23	23	24	21	23	22.88
HVY FF LDNG NT	22	12	20	22	16	19	26	22	19.88
HIGH ALT TAC	21	20	14	15	19	20	17	18	18.00
HVY FF LDNG	19	9	19	20	15	18	18	21	17.38
NVG LDG	15	10	18	21	13	23	20	19	17.38
LOW ALT TAC	20	21	15	14	18	13	16	17	16.75
NVG LOW LEVEL	18	16	17	1	21	17	23	15	16.00
DAY LOW LEVEL	10	23	21	3	22	22	12	13	15.75
CIRCLE APPCH	6	17	22	13	17	15	6	12	13.50
NT LANDING	13	11	6	19	6	8	22	20	13.13
NVG TAKEOFF	14	7	8	16	12	12	19	6	11.75
NDB APPCH	1	19	16	12	10	16	7	11	11.50
TAC DEPT	11	15	9	5	14	4	9	16	10.38
NVG INST APPCH	16	6	5	17	11	3	14	9	10.13
THREAT RESPONSE	7	14	7	2	7	21	8	14	10.00
CAT II APPCH	17	2	11	11	20	9	3	4	9.63
LANDING	12	5	4	18	5	7	13	5	8.63
MSN CPU APPCH	3	18	10	9	9	2	5	8	8.00
NON-PREC APPCH	9	8	12	8	2	11	4	7	7.63
RNAV APPCH	2	13	13	10	8	1	2	10	7.38
INST. APPCH	5	4	2	6	4	5	10	2	4.75
PRECISION APPCH	8	1	3	7	1	10	1	3	4.25
TAKEOFF	4	3	1	4	3	6	11	1	4.13

Table B.1 Skill Required Score by Sub-Category and Interviewee (A-H)

SKILL DIMINISH RATE SCORE									
EVENT	A	B	C	D	E	F	G	H	AVG
RECEIVER AR AP OFF	28	28	27	28	27	28	26	28	27.50
RECEIVER AR NIGHT	27	27	28	27	28	27	25	27	27.00
RECEIVER AR	26	24	26	26	26	26	24	25	25.38
NVG LZ	24	26	25	25	25	25	27	24	25.13
LNDG LZ NIGHT	21	25	23	24	24	17	28	26	23.50
LANDING LZ	23	22	24	23	22	24	21	23	22.75
HVY FF LDNG NT	13	12	20	22	19	16	26	22	18.75
NVG LDG	14	10	18	21	17	22	20	19	17.63
DAY LOW LEVEL	22	23	21	3	21	21	12	13	17.00
HIGH ALT TAC	19	20	14	15	13	19	17	18	16.88
HVY FF LDNG	12	9	19	20	18	15	18	21	16.50
LOW ALT TAC	18	21	15	14	12	18	16	17	16.38
NVG LOW LEVEL	25	16	17	1	20	13	23	15	16.25
NT LANDING	3	11	6	19	10	23	22	20	14.25
CIRCLE APPCH	11	17	22	13	23	6	6	8	13.25
NVG TAKEOFF	4	7	8	16	16	14	19	12	12.00
THREAT RESPONSE	20	14	7	2	7	20	8	14	11.50
TAC DEPT	16	15	9	4	11	11	9	16	11.38
NDB APPCH	9	19	16	12	8	10	7	3	10.50
MSN CPU APPCH	17	18	10	9	5	5	5	9	9.75
NVG INST APPCH	5	6	5	17	9	12	14	10	9.75
LANDING	10	5	4	18	15	2	13	11	9.75
NON-PREC APPCH	15	8	12	8	2	9	4	6	8.00
RNAV APPCH	7	13	13	10	3	7	2	7	7.75
CAT II APPCH	6	2	11	11	6	8	3	5	6.50
TAKEOFF	1	3	1	5	14	1	11	2	4.75
INST. APPCH	2	4	2	6	4	3	10	4	4.38
PRECISION APPCH	8	1	3	7	1	4	1	1	3.25

Table B.1 Skill Diminish Score by Sub-Category and Interviewee (A-H)

PROBABILITY SCORE									
EVENT	A	B	C	D	E	F	G	H	AVG
TAKEOFF	28	28	28	27	28	28	26	28	27.63
LANDING	27	27	27	28	27	27	27	27	27.13
PRECISION APPCH	25	25	25	21	25	26	28	26	25.13
INST. APPCH	26	26	26	22	26	24	25	24	24.88
NON-PREC APPCH	19	24	23	20	24	23	24	25	22.75
NT LANDING	24	23	24	26	22	25	5	22	21.38
LOW ALT TAC	22	15	22	13	20	15	13	18	17.25
RNAV APPCH	10	11	5	17	23	22	23	23	16.75
CAT II APPCH	12	14	12	18	14	21	22	19	16.50
NVG LDG	23	20	20	24	17	8	6	13	16.38
HVY FF LDNG	15	12	19	25	16	17	19	6	16.13
NVG TAKEOFF	17	19	21	23	18	9	7	14	16.00
HIGH ALT TAC	21	21	4	16	21	16	12	15	15.75
TAC DEPT	18	22	15	19	19	5	18	10	15.75
CIRCLE APPCH	11	8	6	15	13	19	21	20	14.13
HVY FF LDNG NT	14	13	18	14	15	13	20	5	14.00
THREAT RESPONSE	20	7	16	8	7	3	11	16	11.00
MSN CPU APPCH	13	9	3	1	8	18	14	21	10.88
RECEIVER AR	3	16	14	11	11	11	16	4	10.75
NVG INST APPCH	16	17	9	12	12	2	3	9	10.00
LANDING LZ	6	3	17	4	6	12	17	8	9.13
RECEIVER AR NIGHT	4	18	8	10	10	10	8	2	8.75
LNDG LZ NIGHT	9	4	11	5	4	14	15	7	8.63
NVG LZ	5	5	10	6	5	6	4	11	6.50
RECEIVER AR AP OFF	2	6	13	9	9	1	9	3	6.50
DAY LOW LEVEL	7	1	2	7	1	4	10	17	6.13

Table B.1 Probability Score by Sub-Category and Interviewee (A-H)

RISK SCORE									
EVENT	A	B	C	D	E	F	G	H	AVG
RECEIVER AR AP OFF	26	24	23	24	27	28	27	27	25.75
RECEIVER AR NIGHT	27	23	24	23	28	27	26	28	25.75
NVG LZ	25	26	21	28	24	23	25	22	24.25
RECEIVER AR	28	22	22	22	26	26	20	26	24.00
LNDG LZ NIGHT	24	25	20	26	25	19	28	21	23.50
LANDING LZ	23	21	19	27	23	22	19	20	21.75
HVY FF LDNG NT	21	16	26	20	22	18	23	24	21.25
DAY LOW LEVEL	13	27	28	25	14	24	17	18	20.75
NVG LDG	22	14	16	21	19	21	22	14	18.63
NVG LOW LEVEL	11	20	18	14	15	25	24	19	18.25
HVY FF LDNG	20	13	25	15	21	17	8	23	17.75
THREAT RESPONSE	7	28	27	12	1	12	16	25	16.00
NT LANDING	19	15	15	19	20	5	18	15	15.75
NVG TAKEOFF	17	7	5	16	17	15	21	13	13.88
LANDING	18	10	14	18	18	2	13	9	12.75
LOW ALT TAC	3	19	17	13	10	10	10	17	12.38
TAKEOFF	16	6	9	17	16	1	14	10	11.13
NVG INST APPCH	10	9	7	9	8	16	12	11	10.25
TAC DEPT	1	17	6	11	13	3	15	16	10.25
CAT II APPCH	15	11	13	7	11	9	4	8	9.75
HIGH ALT TAC	2	18	1	8	9	11	11	12	9.00
CIRCLE APPCH	4	12	10	10	12	7	6	7	8.50
NDB APPCH	8	8	8	6	7	14	3	1	6.88
RNAV APPCH	6	4	11	5	6	8	5	6	6.38
MSN CPU APPCH	5	5	12	4	5	6	7	5	6.13
PRECISION APPCH	14	2	2	1	3	20	1	2	5.63

Table B.1 Skill Required Score by Sub-Category and Interviewee (A-H)

Appendix C

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OHIO

20April 2015

MEMORANDUM FOR DR ALAN JOHNSON

FROM: William A. Cunningham, Ph.D.
AFIT IRB Research Reviewer
2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765

SUBJECT: Approval for exemption request from human experimentation requirements (32 CFR 219, DoDD 3216.2 and AFI 40-402) for An Investigation into the Quantification and Stratification of C-17 Flight Training Events.

1. Your request was based on the Code of Federal Regulations, title 32, part 219, section 101, paragraph (b) (2) Research activities that involve the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior unless: (i) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) Any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

2. Your study qualifies for this exemption because you are not collecting sensitive data, which could reasonably damage the subjects' financial standing, employability, or reputation. Further, the demographic data you are utilizing and the way that you plan to report it cannot realistically be expected to map a given response to a specific subject.

3. This determination pertains only to the Federal, Department of Defense, and Air Force regulations that govern the use of human subjects in research. Further, if a subject's future response reasonably places them at risk of criminal or civil liability or is damaging to their financial standing, employability, or reputation, you are required to file an adverse event report with this office immediately.

WILLIAM A CUNNINGHAM, PH.D.
AFIT Exempt Determination Official

Appendix D

Quantifying C-17 Aircrew Training Priorities

Maj Joseph D. Beal
Advisor: Alan W. Johnson, PhD
Advanced Studies of Air Mobility (ENS)
Air Force Institute of Technology

Introduction

U.S. Air Force C-17 pilots are expected to be mission effective under the harshest and most demanding conditions. The flexible and responsive nature of the Air Force's core mission necessitates a high state of readiness for its pilot force. Currently, C-17 pilot readiness is determined almost exclusively via currency status. That is, a pilot is considered "ready to fight" if they have accomplished all required events within a certain maximum allowed time period of the date on which they plan to fly.

Currency status is intended to be used as an aid to decision makers in the unit to help identify those pilots that are the most prepared to aviate under virtually any wartime or peacetime conditions. Many times, there exists a somewhat large gap in currency and proficiency and unit leadership is provided with near non-existent authority to acknowledge and discard currency status in order to place a more qualified pilot on a crew. Additionally, large amounts of flight hours are consumed in order for pilots to strive for and obtain currency in flight events that are often times not necessary to meet mission accomplishment or contribute to overall proficiency.

Research Questions

1. How does the current C-17 training model compare to the other models by MDS and MAJCOM?
2. Can C-17 training events be quantified and stratified?
3. What flexibility is gained at the squadron, group, and MAJCOM level?

This research explore s quantifiable analytic options regarding C-17 flight training in order to provide the C-17 ATP and unit leadership with most qualified flyers.

Collaboration

HQ AMC/A3TA

AIR FORCE INSTITUTE of TECHNOLOGY

Figure 2.4 Total Flight Events by MDS (AFI 11-2MDS Volume 1, 2006-2008)

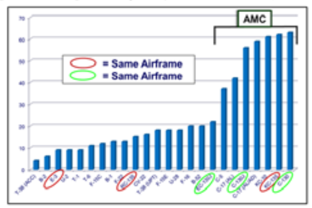

Figure 2.1 Total Number of Flight Events by Mission Type (AFI 11-2MDS Volume 1, 2006-2008)

Figure 4.3 SPR Rank-Score vs Vol 1 Rank-Score

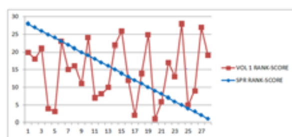

Figure 4.1 Cross Comparison of Skill, Probability, and Risk Scores

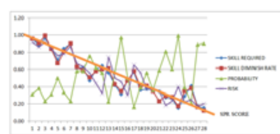

Table 4.6 Event Score Summary

Event	SPR Score	VOL 1 Score	Skill Req	Skill Dim	Prob	Risk
RECEIVER AR NIGHT	26.40	2.27273	0.96	0.96	0.31	0.92
RECEIVER AR	26.02	1.72414	0.88	0.91	0.38	0.86
RECEIVER AR AP OFF	20.20	2.27273	0.96	0.99	0.23	0.92
LNDG LZ NIGHT	18.46	0.56180	0.84	0.84	0.31	0.84
HVY FF LDNG NT	18.07	0.56180	0.71	0.67	0.50	0.76
LANDING LZ	17.59	2.27273	0.84	0.81	0.33	0.78
NVG LZ	16.16	1.13636	0.90	0.90	0.23	0.87
NVG LDG	15.19	1.13636	0.62	0.63	0.58	0.67
HVY FF LDNG	13.38	1.12360	0.62	0.59	0.58	0.63
NT LANDING	10.18	2.27273	0.47	0.51	0.76	0.56
LOW ALT TAC	9.46	0.56180	0.60	0.58	0.62	0.44
HIGH ALT TAC	6.91	0.56180	0.64	0.60	0.56	0.32
DAY LOW LEVEL	5.59	0.56180	0.56	0.61	0.22	0.74
NVG TAKEOFF	5.14	2.27273	0.42	0.43	0.57	0.50
LANDING	4.81	3.57143	0.31	0.35	0.97	0.46
CIRCLE APPCH	3.40	1.12360	0.48	0.47	0.50	0.30
NVG LOW LEVEL	3.45	0.56180	0.57	0.58	0.16	0.65
THREAT RESPONSE	3.25	1.12360	0.36	0.41	0.39	0.57
TAC DEPT	3.15	2.27273	0.37	0.41	0.56	0.37
NVG INST APPCH	1.69	0.56180	0.36	0.35	0.36	0.37
CAT II APPCH	1.63	0.56180	0.34	0.23	0.59	0.35
NON-PREC APPCH	1.15	1.68539	0.27	0.29	0.81	0.18
RNAV APPCH	1.02	1.12360	0.26	0.28	0.60	0.23
TAKEOFF	0.99	5.71429	0.15	0.17	0.99	0.40
MSN CPU APPCH	0.86	0.56180	0.29	0.35	0.39	0.22
NDB APPCH	0.82	0.56180	0.41	0.38	0.21	0.25
INST. APPCH	0.41	5.71429	0.17	0.16	0.89	0.17
PRECISION APPCH	0.33	2.24719	0.15	0.12	0.90	0.20

Methodology

This paper utilized several mathematical computations in order to calculate a resulting SPR Score. Interviews with C-17 mission and flight training experts have provided the sufficient data to the research in order to calculate relative and quantifiable scores based on a given category, to include skill, probability and risk.

Each interviewee ranked each of 28 MDS common flight events based on skill required (S_S), the highest probability (S_P), and the most risk involved (S_R).

The SPR score was calculated as a product of each of the subcategories such that:

$SPR = (S_S \times S_P \times S_R) \times 100$

Conclusions & Recommendations

The conclusion of this research is that qualitative and subjective data from a significant sample set can provide a quantitative means to analyze and apply C-17 training events. Under the current model, the Vol 1 and the experts in this research are in a significant disagreement between which training events are most important based on required skill, probability of the event occurring on a mission, and the risk if the event is not performed correctly.

Furthermore, this research highlights relatively drastic differences between MAJCOMs when determining the minimum currency training events for a pilot. AMC requires significantly more currency events in a training period than that of ACC and AFSOC, even among like airframes.

Implications

Due to this research, MC now has quantifiable and stratifiable means to assess and administer its training events. It is now possible for AMC to determine a calculable and standardized threshold of authority in which squadrons and groups have clear guidance on what can be waived, by which level of authority, and how often it should be waived.

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14. ABSTRACT

This research investigates the possibility of prioritizing and quantifying of C-17 pilot training/currency flight events. Through interviews and surveys of C-17 experts, including high-time instructor and evaluator pilots, this research provides quantifiable coefficients for each of twenty-eight selected C-17 flight events. The coefficients are calculated as a product of the impact rankings of four categories labeled as an SPR Score. This SPR Score provides decision makers from the squadron level up through and including MAJCOM level a means by which to prioritize training events within a limited resource environment.

15. SUBJECT TERMS

C-17, AMC, Proficiency, Training Model, Flight Currency, Risk Analysis

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